DNI NEVADA

Operating Manual

Impulse 3000

Defibrillator Analyzer

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DNI NEVADA

Impulse 3000 Defibrillator Analyzer

Operating Manual

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DNI NEVADA
INCORPORATED

To order this manual, use Part Number 9508-0184.

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Return Procedure

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, to be obtained from our Order Processing Department. All items being returned must be sent freight prepaid to our factory location.

Certification

This instrument was thoroughly tested and inspected and found to meet DNI Nevada's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Institute of Standards and Technology (NIST). Devices for which there are no NIST calibration standards are measured against in-house performance standards using accepted test procedures.

Warranty

Warranty and Product Support

This instrument is warranted by DNI Nevada against defects in materials and workmanship for one full year from the date of original purchase. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to DNI Nevada, Inc. This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than DNI Nevada. IN NO EVENT SHALL DNI NEVADA BE LIABLE FOR CONSEQUENTIAL DAMAGES.

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When you return an instrument to DNI Nevada, Inc., for service, repair, or calibration, we recommend using United Parcel Service, Federal Express, or Air Parcel Post. We also recommend that you insure your shipment for its actual replacement cost. DNI Nevada will not be responsible for lost shipments or instruments that are received in damaged condition due to improper packaging or handling. All warranty claim shipments must be made on a freight prepaid basis. Also, in order to expedite your claim, please include a properly completed copy of the Service Return Form. Recalibration of instruments, which have a recommended semiannual calibration frequency, is not covered under the warranty.

Warranty Disclaimer

Should you elect to have your instrument serviced and/or calibrated by someone other than DNI Nevada, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to DNI Nevada for factory service and calibration, especially during the original warranty period.

In all cases, breaking the tamper-resistant Quality Seal should be avoided at all cost, as this seal is the key to your original instrument warranty. In the event that the seal must be broken to gain internal access to the instrument (e.g., in the case of a customer-installed firmware upgrade), you must first contact DNI Nevada's technical support department at 702-883-3400. You will be required to provide us with the serial number for your instrument as well as a valid reason for breaking the Quality Seal. You should break this seal only after you have received factory authorization. Do not break the Quality Seal before you have contacted us! Following these steps will help ensure that you will retain the original warranty on your instrument without interruption.

WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. DNI Nevada will not be responsible for any injuries sustained due to unauthorized equipment modifications.

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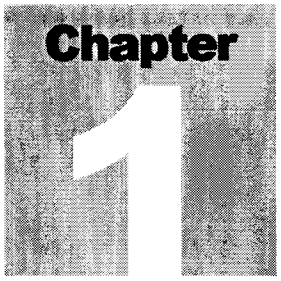
Abbreviations

A	ampere
BPM	beats per minute
c	centi- (10^{-2})
cm	centimeter
°C	degrees Celsius (centigrade)
°F	degrees Fahrenheit
EEPROM	electrically erasable PROM
ECG	electrocardiograph or electrocardiogram
EUT	equipment under test
EPROM	erasable PROM
Hz	hertz
in	inch
J	joule
k	kilo- (10^{3})
kg	kilogram
kHz	kilohertz
LCD	liquid crystal display
M	meg(a)- (10^{6})
MHz	megahertz
MΩ	megohm
m	-meter
µ	micro- (10^{-6})
µs	microsecond
m	milli- (10^{-3})
mA	milliampere
mm	millimeter
ms	millisecond
mV	millivolt
Ω	ohm
lb	pound
PROM	programmable read-only memory
s	second
V	volt



General Information

This chapter includes the functions, features, and specifications for the Impulse 3000 Defibrillator Analyzer.

The Impulse 3000 is a precision instrument that makes the measurements required to thoroughly test the performance of defibrillators. The main function of the Impulse 3000 is to measure the energy output of a defibrillator.

The instrument contains a load resistance—50 ohms—approximating that of the human body. The defibrillator paddles are placed on the contact plates of the Impulse 3000 and the defibrillator is discharged into the load. The instrument calculates and displays the energy delivered.

Functions

The Impulse 3000 performs the following functions for testing defibrillators:

- Measures the energy delivered to the load.
- Performs a cardioversion test by simulating a heartbeat at the ECG leads and measuring the delay time from the R-wave peak to the firing time of a synchronized defibrillator. The ECG signal is also present on the paddle contact plates for pickup by the defibrillator directly through the paddles.
- Outputs a voltage–attenuated signal of the defibrillator pulse in real time for viewing on an oscilloscope.
- Plays back the defibrillator pulse at a slow speed out the ECG leads for viewing on a cardiographic strip chart recorder.

With Option 001

The Impulse 3000 with Option 001 performs the following functions for testing defibrillators:

- Plays a series of waveforms out the ECG leads suitable for testing the performance of ECG monitors.
- Plays a series of heartbeat-simulating ECG waveforms including several rates and arrhythmias.
- Plays a special series of ECG waveforms that interact with the defibrillator pulse for EMT-D (Emergency Medical Technician-Defibrillator) training purposes including ventricular and atrial fibrillation, and the result of defibrillation.
- Runs automated sequences of tests that can be custom-programmed (CASO) for specific defibrillators and that include energy level tests with programmed limits, a maximum energy test that also measures the charge time for a full-scale pulse, and cardioversion tests. The test results can be printed via the RS-232 output, formatted as a one–page report.

The Impulse 3000 can now interface with medTesters that have software versions of 3.16 or above. After the defibrillator is discharged into the Impulse 3000, a data string is sent to the medTester containing the defibrillator energy and cardioversion delay time.

Features

The Impulse 3000 has two energy ranges. The low range is designed to be especially useful to test low–power defibrillators, including internal defibrillators.

An internally generated pulse, similar to an actual defibrillator pulse, can be used to test the equipment under test (EUT) or to simulate a pulse when desired.

The paddle contact plates are connected to the ECG signal so the defibrillator can pick up the heartbeat waveform through its paddles. The paddle contact plates have a provision (a hole in the mounting screw) for plugging in special contacts for internal defibrillator paddles. These contacts are included as standard accessories. In addition, special contacts for connecting to specific defibrillators are available as optional accessories.

The Impulse 3000 can be powered from a battery for portable operation, or from the line with the Battery Eliminator.

The Impulse 3000 uses a true differential amplifier input so that the defibrillator can be fired from either polarity. The energy is measured correctly even from grounded defibrillators. For proper polarity of the scope output, put the apex (+) paddle on the right and the sternum (-) paddle on the left.

The Impulse 3000, under control of a microprocessor, measures and stores the instantaneous voltage of the defibrillator pulse every 125 microseconds, 512 times, giving a measurement window of 64 milliseconds.

The instrument has a serial RS–232 port that can be used to output test results to a printer, the medTester (software version 3.16 and above), or other devices.

The medTester interfaces with the Impulse 3000 via a specialized cable available from DNI Nevada and the RS-232 ports of both units.

Instrument Specifications

The Impulse 3000 is designed to operate up to the energy levels as specified below. The actual accuracy of the Impulse 3000 has been verified and tested at 360 joules using an Edmark waveform-type defibrillator.

Load 50 Ω ±1%

High Range

Maximum energy:	360 J at specified accuracies Note: Readings are obtainable at energies up to 700 J.
Maximum voltage:	6000 V
Maximum current:	120 A
Accuracy:	±2% of reading for 100-360 J ±2.0 J for <100 J Note: Accuracy specified is for energy levels ≤360 J.
Trigger level:	100 V
Real time scope output:	1 V/1000 V
Playback amplitude:	1 mV/1000 V Lead I
Test pulse:	100 ±4 J

Low Range

Maximum energy:	50 J
Maximum voltage:	1200 V
Maximum current:	24 A
Accuracy:	±2% of reading for 20-50 J ±0.4 J for <20 J
Trigger level:	20 V
Real time scope output:	1 V/200 V
Playback amplitude:	1 mV/200 V Lead I
Test pulse:	Approximately 4 J

Display Resolution 0.1 J

Measurement Time Window
64 ms

Cardioversion Measures delay time ±2 ms

Real Time Scope Output
BNC jack
Active output (requires power)

ECG Leads

Low-level ECG posts 5 color-coded special purpose binding posts connect to snap electrodes and 3.2- and 4.0-mm pins. Lead I has a 1-mV signal amplitude for most waveforms.

Hi-level ECG jack ¼-in standard phone jack with waveform amplitude of 1 V/mV of the low-level Lead I signal

Defibrillator paddle contact plates
1 mV signal same as Lead I

Slow Time Playback Time expansion of 200:1 of the defibrillator pulse played back at the ECG leads

Performance Test Waveforms—Option 001

- 2-Hz square
- 4-second pulse
- Sine: 10, 40, 50, 60, 100 Hz, and 1 kHz
- 2-Hz triangle
- ECG: 30, 60, 120, and 240 BPM

Accuracy (Lead I @ 1 mV):

Frequency/Rate: ± 1% of selection
Amplitude: ± 5%

Custom Auto Sequence Operation (CASO)—Option 001

20 automated sequences

Sequences can be custom-programmed to perform

- up to 20 energy tests
- maximum energy discharge time test
- 3 cardioversion delay time tests

Sequences stored permanently in nonvolatile memory

Test results sent to the RS-232 output formatted as one-page reports

Sequences initialized from the factory for 18 popular defibrillators

EMT-D (Emergency Medical Technician-Defibrillator) Interactive Training Sequences—Option 001

7 emergency scenarios

1 elective cardioversion simulation

ECG Waveforms—Option 001

Normal sinus rates 30, 60, 80, 120, 160, 200, 240, 300 BPM

Accuracy (Lead I @ 1 mV):

Rate: ± 1% of selection

Amplitude: ± 5%

Arrhythmias 24 selections

General Specifications

Display

2- x 24-character LCD alphanumeric

Serial Port

RS-232 output only

Rates: 300, 600, 1200, 2400 baud
Data line only—no handshake

Power Requirements

9-volt battery* for a 20- to 25-hour life

* Use only alkaline batteries—
Duracell MN1604 or equivalent.

or Line-operated via Battery Eliminator
Domestic (115 VAC)
or European (230 VAC)

Temperature Ranges

Operating

15° to 35°C (59° to 95°F)

Storage

0° to 55°C (32° to 131°F)

Size

23.3 cm L x 22.4 cm W x 11.5 cm H
(9.2 in L x 8.8 in W x 4.5 in H)

Weight

2.3 kg (5 lb)

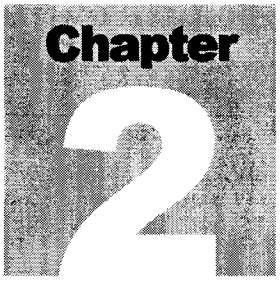
Accessories

Standard	DNI Part #
• Battery Eliminator	
Domestic (115 VAC)	1201-0019
or European (230 VAC)	1201-0023
• Battery, 9-volt alkaline (Duracell MN1604)	1001-2001
• Internal paddle contacts (2)	5215-0198
• Operating Manual	9508-0184
• Vinyl carrying case	9530-0025

Optional

• Service Manual	9508-0275
• Impulse 3000 to Printer/DTE RS-232 Cable Assembly	3010-0296
• Impulse 3000 to medTester/PC RS-232 Cable Assembly	3010-0300
• Special disposable defibrillator electrode adapters*	

* Refer to the current DNI Nevada Price List for availability, part number, and price.



Installation

This chapter contains information for making a visual inspection of the instrument, processing a claim, and repackaging for shipment.

Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

Claims

Our routine method of shipment is via common carrier, FOB origin. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim.

If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact DNI Nevada or your local sales representative.

Warranty Repair

The warranty statement for this product is at the front of this manual.

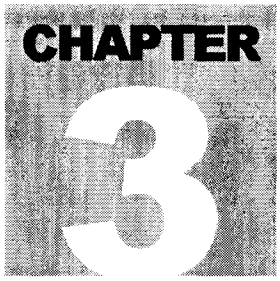
When shipping an instrument to DNI Nevada for repair, complete the Service Return Form and attach to the instrument. Completing this form will help to ensure timely repair of your instrument.

Use the original carton and packaging material for shipment. If they are not available, we recommend the following guide for repackaging:

a) Use a double–walled carton of sufficient strength for the weight being shipped.

b) Use heavy paper or cardboard to protect all instrument surfaces. Use nonabrasive material around all projecting parts.

c) Use at least four inches of tightly packed, industrial–approved shock–absorbent material around the instrument.



Operating Instructions

Use this chapter to familiarize yourself with the controls and their functions, as well as learn how to operate the Impulse 3000 Defibrillator Analyzer.

Instrument Familiarity

The following chart offers an overview of the Impulse 3000 controls and features and their functions. Detailed usage and operating instructions can be found later in this chapter.

Control/Feature	Function
POWER (ON/OFF) Switch	Turns power to the instrument on and off.
RANGE (HI/LO) Switch	Selects the high or low range of defibrillator energy.
F1, F2, F3, F4 Function Select Keys	Select whatever function is displayed on the lower line menu above that particular key.
MENU / ESC Key	Selects a new menu for the Function Select Keys or escapes out of a procedure.
STERNUM / APEX (+) Paddle Contacts	Where the defibrillator paddles are placed to discharge into the instrument. Also have ECG signal whenever active.

Control/Feature	Function
RL, RA, LA, LL, V1 Low Level ECG Posts	5 color-coded special purpose binding posts that mate with snap electrodes and 3.2- and 4.0-mm pins.
HI LEVEL OUT Jack	¼ inch standard phone jack with waveform amplitude of 1 volt per mV of the low-level Lead I signal.
REAL TIME SCOPE OUT Jack	BNC jack for the attenuated signal in real time.
RS-232 SERIAL PORT	5-pin circular DIN jack.
BATTERY ELIMINATOR Jack	Used to plug in the line-operated battery eliminator.
Display	Displays messages, test results, and menus for function selection.
Battery Compartment	Houses the battery. Access door opens to service the battery.

Menus And Function Keys

The Impulse 3000 uses a general purpose display and programmable function keys to obtain the most flexible operation with a minimum of controls. Generally, the upper line of the display is used for messages and the lower line is used to show menus. The function keys are numbered F1 through F4.

A function is selected by pushing the key directly below the desired menu item. A menu item appears in **UPPERCASE** and is two to six characters. Messages also are sometimes displayed on the lower line.

The **MENU/ESC** key is used in various ways to select a new menu or to escape out of a procedure. If the display shows a "**>**" at the right of the menu line, then pressing **MENU/ESC** selects another menu page at the same level as the current page. Otherwise, this key escapes from the current procedure or menu level and returns to the previous level of menus. **MENU/ESC** is also used to skip certain things such as portions of an autosequence or waveform playback.

You can recognize the main menus by "IMPULSE 3000" showing on the top line.

- With Option 001 there are three main menu pages. Pushing MENU/ESC selects the next page from the one currently displayed.
- Without Option 001 there is only one main menu.

Real Time Scope Output

The Impulse 3000 has a BNC jack for viewing the energy waveform on an oscilloscope in real time.

The amplitude of this signal is 1 volt per 1000 volts of the actual waveform on the HI range and 1 volt per 200 volts on the LO range. The signal requires that the power to the instrument is turned on.

ECG Outputs

The Impulse 3000 has a variety of waveforms it sends out the ECG outputs including performance test waves, ECG heartbeat simulations, and playback defibrillator pulses.

There are low-level signals on the top panel ECG posts and a high-level signal at the side panel phone jack. There is also a low-level signal on the paddle contacts for defibrillators that have the capability of picking up the ECG signal through their paddles.

The amplitude of a given waveform is always specified to be the Lead I amplitude. All the other signals are in a proportion relative to the Lead I amplitude as follows. The amplitudes shown are for a Lead I amplitude of 1 millivolt (mV).

Lead I:	1.0 mV (LA - RA)
Lead II:	1.5 mV (LL - RA)
Lead III:	0.5 mV (LL - LA)
V Lead:	1.5 mV (V - 1/3 (LL+LA+RA))
Hi Level Out Jack:	1 volt
Paddle Contacts:	1 mV between paddles

Defibrillator Energy

Energy is defined as the integral over time of the instantaneous power output of a defibrillator. Power is equal to voltage squared, divided by resistance.

$$E = \int p\,dt = \int v^2/R\,dt = \int v^2\,dt\,/R$$

The Impulse 3000 measures and stores the instantaneous voltage of the pulse every 125 microseconds (μs), 512 times for a total time of 64 milliseconds (ms). Then it squares all the instantaneous voltages, sums them, multiplies by 125 μs, and divides by the load resistance, 50 Ω.

$$E = (\Sigma\, v^2) \bullet dt\,/R = (\Sigma\, v^2) \bullet 125\ \mu s\,/50\ \Omega$$

The unit of energy is the joule which is equal to a watt-second (a watt for a duration of a second).

Energy Waveform Playback

The Impulse 3000 plays back the defibrillator energy waveform with a time-expanded scale suitable for a cardiographic strip chart recorder. The signal is played back on the ECG outputs.

The time scale of the playback is expanded 200 to 1 so that at a chart paper speed of 25 mm/s, 1 mm equals 200 μs and 5 mm equals 1 ms.

The Lead I amplitude is 1 mV per 1000V of the actual waveform on the HI range and 1 mV per 200V on the LO range.

Additionally, a marker is added just prior to the waveform. In the HI range the marker is 2 mV (2000V) for 0.4s. In the LO range the marker is 2 mV (400V) for 0.2s followed by 1 mV (200V) for 0.2s.

The markers give an amplitude standard and also show which range was used.

The waveform playback itself takes 12.8s and with the markers takes a total time of 13.2s.

Test Pulse

The Impulse 3000 has an internally generated test pulse in the shape of a typical defibrillator pulse. This pulse can be used to test the instrument for proper operation, or just to substitute for a real defibrillator pulse, such as during a special sequence.

The test pulse is set to 100 joules in the **HI** range and is approximately 4 joules in the **LO** range.

To fire a test pulse:

- Push a function key, usually **F4**, whenever the instrument is in a state of readiness for accepting a pulse.

  The energy of the test pulse only reads out in the Manual mode. In Autosequence and EMT-D modes, "**XXX.X**" is displayed for energy so as not to be confused with an actual defibrillator pulse.

Note

On the **HI** range, the test pulse should read 100 ± 4 joules.

This is not a calibration pulse and should not be used as an indication of the overall accuracy of the instrument. It is a good functional check, however, because it exercises the measurement circuitry and software.

Cardioversion Delay Time

The Impulse 3000 can measure the cardioversion delay time of synchronized defibrillators.

In this mode the instrument outputs a 60 beats-per-minute (BPM) ECG waveform while it waits for a defibrillator pulse. When the pulse comes, the time delay is computed from the R-wave peak of the last heartbeat to the onset of the defibrillator pulse.

The ECG waveform is 1 mV peak on Lead I.

Energy Range Selection

To select the proper energy range:

- Use the **RANGE** switch.

  For most general usage, select the **HI** range.

  For low energy testing where the energy does not exceed 50 joules and the peak voltage does not exceed 1200 volts, select the **LO** range.

  If the maximum voltage for the selected range is exceeded, "**overrange**" is displayed.

Discharging the Defibrillator

To discharge the defibrillator:

- Place the defibrillator paddles firmly on the paddle contact plates, and fire the defibrillator.

  The apex (+) paddle should be on the right plate and the sternum (-) paddle should be on the left. This assures correct polarity of the signal at the Real Time Scope Output.

  Reversing the paddles will not harm anything, even with grounded defibrillators, and will still give a correct energy reading, but the Scope Output polarity will be reversed.

Note

Do not use any electrode paste on the paddles when testing. It is not necessary and will make a mess out of the instrument.

Defibrillator-Induced Electromagnetic Noise

When fired, defibrillators sometimes generate electromagnetic noise. This noise comes from a mechanical relay that switches the output pulse to the paddles. The amount of noise varies depending on the type and age of the defibrillator as well as the pulse energy level. Occasionally, if enough noise is generated, the Impulse 3000 may malfunction by resetting to a power-up state or by not responding to keystrokes.

Steps to Prevent Impulse 3000 Susceptibility to Noise

DNI Nevada is researching ways to prevent this noise from interfering with the Impulse 3000's operation. However, we still haven't eliminated all of the Impulse 3000's susceptibility to noise. To help reduce the Impulse 3000's susceptibility, you can take the following steps:

1. Move the Impulse 3000 as far away from the defibrillator as possible. Then dress the defibrillator cables so that they come directly over the Impulse 3000's forward edge. In addition, keep the defibrillator cables away from any other cables.

2. Connect the ECG leads only when necessary (noise can be coupled through them). When performing tests, such as cardioversion tests, which do require ECG leads, reduce the energy level and dress the ECG leads directly backwards (away from the Impulse 3000). You should also keep the ECG leads away from the defibrillator's cables and paddles.

3. Unplug the Impulse 3000 battery eliminator and operate on battery power.

4. Dress the interconnect cable away from the defibrillator when using the Impulse 3000 with a medTester. Also, place the medTester on the opposite side of where the defibrillator sits in conjunction to the Impulse 3000.

Internal Paddles

To test a defibrillator with internal type paddles:

- Use the internal paddle contacts that are provided as accessories.

  These contacts have banana plugs that plug into the holes in the screws holding on the regular paddle contacts and plastic insulators that cover the regular contacts.

Special Contacts

Some defibrillators, such as automatic models, have special connectors that attach to electrode pads stuck on the patient.

DNI Nevada has special adapters for some of these defibrillators available as optional accessories. They are like the internal paddle contacts except they have special connectors on top to mate with the defibrillator connector.

Adapters are available for defibrillators from the following companies:

- Physio Control
- R2/Darox
- Cardiotronics
- Spacelabs
- Marquette
- Laerdal
- Hewlett-Packard
- Zoll

To order, see the current DNI Nevada price list for part numbers.

Viewing Angle Adjustment

The Impulse 3000 has a liquid crystal display that can be adjusted for optimal viewing angle.

To adjust the viewing angle:

1. Push **UTIL** from the main menus to enter the **UTILITY MENU.**
2. Push **VIEW.**
3. Push **DOWN** or **UP** to move the viewing angle through its range of **1** through **8.**
4. If desired, push **STORE** to store the adjustment permanently. Otherwise it will be lost when power is turned off.
5. Push **MENU/ESC** to return to the main menus.

RS-232 Serial Port Setup

To set up the RS-232 serial port:

1. Push **UTIL** from the main menus to enter the **UTILITY MENU**.
2. Push **RS232** to enter **RS232 SERIAL PORT SETUP**.
3. Select **ENABLE**.
4. Push **OFF** and **STORE** to disable the RS-232 port, or **ON** and **STORE** to enable the port.

To set the baud rate:

1. Push **BAUD** from the **RS232 SERIAL PORT SETUP**.
2. Push **DOWN** or **UP** to set the baud rate to 300, 600, 1200, or 2400.
3. If desired, push **STORE** to store the baud rate permanently. Otherwise it will be lost when power is turned off.
4. Push **MENU/ESC** to return to the **UTILITY MENU**.

Some printers without adequate internal buffers may require a delay in data transmission from the Impulse 3000 in order to function correctly.

To set the transmit delay (if needed):

1. Select **DELAY** from **RS232 SERIAL PORT SETUP**.
2. Select **CR** to set the carriage return.
3. Use the **DOWN** and **UP** function keys to select a delay from 0 to 4 seconds.
4. Press **STORE** to store the information permanently.
5. Select **LF** to set the line feed delay.
6. Use the **DOWN** and **UP** function keys to select a delay from 0 to 4 seconds.
7. Press **STORE** to store the information permanently.
8. Push **MENU/ESC** to return to the **RS232 SERIAL PORT SETUP**.

To output a test message at the serial port:

1. Push **TEST** from the **RS232 SERIAL PORT SETUP**. The message repeats as long as the button is held down.
2. Push **MENU/ESC** to return to the **UTILITY MENU.**
3. Push **MENU/ESC** again to return to the main menus.

Power On/Off

Whenever the instrument is turned off and back on again, leave it off for a minimum of two seconds to allow the reset circuit to discharge.

Low Battery

If the battery voltage goes below 6.2 volts for 8 seconds, the display shows "**LO BAT.**"

1. Either replace the battery or use the Battery Eliminator.
2. Turn the power off and on again to use the instrument.

Battery Replacement

To replace the battery:

1. Open the door on the side of the instrument.
2. Remove the old dead battery and snap the new battery onto the snap terminals. Do not touch the battery to the terminals backwards as that excessively drains the battery.
3. Close the door.

Note

Use a 9-volt alkaline battery (Duracell MN1604 or equivalent). Mercury, air, or other 9-volt batteries will not work as well so are not recommended.

Manual Tests (Base Model): Energy Testing

To enter the **ENERGY** menu:

1. Push **ENERGY** from the main menu.

   The Impulse 3000 operates in two modes. In the normal mode, a defibrillator can be fired at any time whenever the display shows "**ready.**"

2. Discharge the defibrillator into the instrument load. Alternately, the test pulse can be fired by pushing **TEST**.

   The Impulse 3000 calculates and displays the energy (in joules) delivered to the load.

   Between pulses, the instrument continuously plays back the stored waveform of the last pulse at the ECG outputs, every 13.2 seconds.

3. Push **VFIB** to change the mode so that the Impulse outputs a ventricular fibrillation (v-fib) ECG waveform while waiting for the defibrillator pulse. In this mode, the display shows "**ready/vfib**" indicating it is outputting the v-fib waveform and is ready for the defibrillator to fire.

   The v-fib mode allows automatic defibrillators to be tested as they will not fire unless they see v-fib. The v-fib waveform can be sensed right at the Impulse paddle contacts if desired.

   In the v-fib mode, after a pulse, the instrument plays back the defibrillator waveform once (displaying "**playback**") which takes 13.2 seconds.

4. Push **MENU/ESC** during playback to end and go directly to "**ready/vfib.**" Now a new pulse can be fired.

   Once the v-fib mode has been entered, it remains active.

5. Push **MENU/ESC** to return to the main menus.

Manual Tests (Base Model): Cardioversion Analysis

To enter the CARDIOVERSION menu:

1. Push CARDIO from the main menu. When the display shows "ready," the instrument outputs a 60 beats-per-minute ECG wave at the ECG outputs.

2. Set the defibrillator to the synchronized cardioversion mode.

3. Discharge the defibrillator into the instrument load. Alternately, the test pulse can be fired by pushing TEST.

   The Impulse 3000 measures the delay time in milliseconds between the peak of the ECG R-wave and the firing of the defibrillator pulse and displays this time (ms for milliseconds). If the test pulse was fired, the delay time will be 20 ms.

   The instrument also calculates and displays the energy (J for joules).

   The instrument plays back the defibrillator waveform once (displaying "playback") which takes 13.2 seconds.

4. Push MENU/ESC during playback to end and go directly to "ready."

   When the display again shows "ready," a new pulse can be fired.

5. Push MENU/ESC to return to the main menus.

Option 1:
ECG Performance Test Waveforms

The Impulse 3000 puts out a series of waveforms designed to test electrocardiographic monitors for performance. The waveforms are as follows:

Waveform	Description
2-Hz square	A square wave at 2 Hz and 1 mV amplitude. For testing gain and damping.
4-second pulse	A pulse for 4 seconds at 1 mV amplitude. For testing low frequency response.
Sine: 0.05, 0.5, 1, 10, 25, 30, 40, 50, 60, 100 Hz; 1 kHz	Sine waves at the indicated frequency, 1 mV amplitude. For testing frequency response.
2-Hz triangle	A triangle wave at 2 Hz, 1 mV amplitude. For testing linearity.
ECG at 30, 60, 120, and 240 BPM	Heartbeat waveforms at the indicated rate in beats per minute. For testing heart rate accuracy and alarm functioning. Amplitude is 1 mV peak R-wave.

To enter the **PERFORMANCE WAVES** menu:

1. Push **PERF** from the main menu.
2. Then push either **AUTO** for the automatically sequenced or **MAN** for the manually sequenced group of waveforms.

Automatic Performance Waves

In the AUTO mode, the waveforms are arranged in a convenient sequence to make routine testing easier. Some of the waves are set to run only for a certain time and others to run continuously.

Convention

The F4 function key advances the waveforms through the sequence.

- If the key is labeled "ADV," then that wave runs continuously until ADV is pushed.
- If the key is labeled "(ADV)," then the wave runs for its allotted time. It is not necessary to push (ADV), but it can be pushed if desired to interrupt a waveform.

At any time during the sequences, if MENU/ESC is pushed, the sequence is aborted and the instrument returns to the PERFORMANCE WAVES menu.

The automatic sequence runs as follows. Note that "Autoperf sequence" is displayed in the lower line.

1. 2-Hz square wave runs continuously. Push ADV.
2. 4-second pulse runs once and autoadvances.
3. All the sine waves run for 2 seconds each and autoadvance.
4. 2-Hz triangle wave runs continuously. Push ADV.
5. ECG at 60 BPM runs continuously. Push ADV.
6. ECG waves at 30, 60, 120, and 240 BPM run for 30 seconds each, autoadvancing.
7. The sequence returns to the PERFORMANCE WAVES menu.

Note

The ECG rates are arranged so that in step **5**, at 60 BPM, time is allowed to set up the monitor including the rate alarms which can be tripped by the rates in step **6**.

Manual Performance Waves

In the MAN mode, each waveform runs continuously. "Manual perf" is displayed on the lower line.

1. Push UP or DOWN to ascend or descend through the list of waves.

   The top of the list wraps around to the bottom.

2. Push MENU/ESC to return to the PERFORMANCE WAVES menu.

Option 1: Autosequences

The Impulse 3000 has the ability to run 20 different automated sequences of defibrillator tests.

Operation

To enter the SELECT AUTOSEQUENCE menu:

1. Push AUTO from the main menu.
2. Select the desired autosequence.

Note

Descriptions of the preprogrammed autosequences are found in the *Custom Autosequence Operation (CASO)* section later in this chapter.

See the *CASO* section also for instructions on how to custom program the autosequences to match the local testing requirements.

Printing Setup

The Impulse 3000 outputs the results of an autosequence via its RS-232 serial port. The output is designed to create a one-page report for each sequence performed.

The Impulse prints out a header containing blank user and device information fields to be filled in by the operator.

To set up to print the results of an autosequence:

1. Use a printer with a serial port.
2. Set the Impulse 3000 baud rate to match the printer.
3. In case the printer cannot print as fast as the data it is sent, reduce the baud rate of both the Impulse and the printer.

The printer must be connected to the Impulse for the entire autosequence because the data is sent after each step of the sequence. Each line sent to the printer ends with a Carriage Return followed by a Line Feed. The entire sequence ends with a Form Feed character.

Energy Level Tests

In the automated sequences, first a set of up to 20 Energy Level tests is performed. The Impulse 3000 displays "ENERGY TESTS" and shows the programmed limits of variation allowed (in percent).

To begin the Energy Level tests:

1. Set the RANGE switch to the proper range for the energy level programmed for each step.

   The LO range is used for energies of 50 joules or less and the HI range is used for energies greater than 50 joules.

   The display prompts to switch to a range for the next test if the range switch is not already in the correct position. When the range is correct, the sequence continues.

2. At the prompt, set up and charge the defibrillator to the preprogrammed energy level for that step.

3. When charged, fire the defibrillator into the Impulse 3000.

   The energy is calculated and checked for accuracy within the programmed limits.

   If it is within the limits, the energy is displayed and printed. The printout shows the programmed set level and the actual energy measured.

   If the energy is outside the limits, the energy is displayed with a "#" in front. Also, the limits for that step are displayed in parentheses.

4. At the prompt, choose between repeating that step or advancing to the next step.

   If advanced, the data is accepted and the printout shows a "#" in front of the energy to indicate an out-of-spec measurement.

The Energy Level test number is shown on the left followed by a colon (:). The results of the last test appear on one line and the setup energy of the next test on another.

5. Continue to follow this procedure through this set of tests.

   Up to 20 steps can be programmed.

Convention

- For **any** of the tests in an autosequence, pushing **F4** will fire the Impulse 3000 test pulse and the display will show "XXX.X J." The sequence then advances to the next test. This feature can be used to skip any test if desired and still complete the rest of the autosequence.
- During the **Energy Level** tests, pushing **MENU/ESC** at any time skips the sequence out of this set of tests and moves to the **MAXIMUM ENERGY** test.

Maximum Energy Test

This test measures the maximum energy setting of the defibrillator, comparing it with the programmed high and low limits. It also measures the time it takes for the defibrillator to charge to its maximum level.

The Maximum Energy test is always done in the **HI** range.

In the automated sequence, the Maximum Energy test is optional.

To perform the Maximum Energy test:

1. Set the defibrillator to its maximum energy setting.
2. Simultaneously push **F1** on the Impulse and the defibrillator charge button.
3. When the defibrillator is charged, immediately fire it into the Impulse.

   The display shows the energy result and the high and low programmed limits in parentheses.

   If the energy is outside these limits, a "#" is placed in front of the energy reading.

The charge time is displayed "Time=" in seconds.

4. At the prompt, choose to repeat the test or advance to the cardioversion tests.

5. When ADV is pushed, the results of this test are printed.

Cardioversion

Cardioversion tests are optional in the automated sequences. There are three.

For each test the delay time and energy are measured, displayed, and printed.

To perform the Cardioversion tests:

- Push F4 and advance to the next test.

End of Sequence

After the Cardioversion tests are completed, blank fields for comment and next test due date are printed.

Finally, a form feed command is sent to eject the paper and set up for the next sequence.

Option 1:
Custom Autosequence Operation (CASO)

Any of the 20 autosequences can be custom-programmed as desired.

To get to the CUSTOM AUTOSEQUENCES menu:

- Push CASO from the main menu.

Factory-Initialized Autosequences

The factory preprogrammed autosequences for particular defibrillators are the following. (The last two sequences have been left blank for the user to program.)

Autosequence #	Name	Defibrillator Make and Model
1	LP4	Physio-Control Lifepack 4
2	LP5	Physio-Control Lifepack 5
3	LP6	Physio-Control Lifepack 6
4	LP6S	Physio-Control Lifepack 6S
5	LP7	Physio-Control Lifepack 7
6	LP8	Physio-Control Lifepack 8
7	M/D3	Datascope M/D3
8	HP660	Hewlett-Packard 78660A
9	NK7K	Nihon Kohden 7000
10	HS2K	Laerdal Heart Start 2000
11	AOLWN	American Optical
12	M/D4	Datascope M/D4
13	M/D2	Datascope M/D2
14	M/D2J	Datascope M/D2J
15	HP670	Hewlett-Packard 78670A
16	HP431	Hewlett-Packard 43100
17	ZOLL	Zoll PD2000
18	LP10	Physio-Control Lifepack 10
19		
20		

Tables of the factory-initialized autosequences 1 through 18 follow later in this section. These tables show the complete test sequences for a factory-initialized instrument. A blank table is also provided for operators to copy and to enter their own figures as records of their own custom sequences.

To re-enter factory-initialized sequences:

1. Push **INIT** from the **CUSTOM AUTOSEQUENCES** menu.

2. The decision to re-enter factory-initialized sequences must be confirmed by pushing **YES** (or push **NO** or **MENU/ESC** to abort the function).

   If you select YES, any sequences that have been custom programmed will be erased.

3. Push **MENU/ESC** from the **CUSTOM AUTOSEQUENCES** menu to return to the main menu.

Custom Programming

Convention

At any time during the following steps, if **MENU/ESC** is pushed, the sequence is abandoned.

To custom program an autosequence:

1. Push **MAKE** from the **CUSTOM AUTOSEQUENCES** menu.

2. Select the name of the sequence to be customized.

3. Using the function keys as indicated in the display, enter the new **NAME** and push **ENTER**.

4. Enter the energy levels for each step (up to 20 steps). Pushing **DOWN** or **UP** adjusts the number on the display. Holding the button down makes the number count faster. Push **ENTER** to store the energy level test and advance to the next step.

5. When enough steps have been programmed, push **END**.

6. Enter the "+" limits in percent for the energy level tests by pushing **DOWN** or **UP** followed by pushing **ENTER**.

7. Next enter the "-" limits in percent for the energy level tests by pushing **DOWN** or **UP** followed by pushing **ENTER**.

8. Answer the question **V-FIB FOR ENERGY TESTS?** by pushing **YES** or **NO**.

   If **YES**, a ventricular fibrillation ECG waveform is output for the energy level tests and the maximum energy test. This allows automatic defibrillators to be tested because they will not fire unless they see v-fib. The v-fib waveform can be sensed right at the Impulse paddle contacts if desired.

   If **NO** is pushed, only the previous pulse playback waveform is output.

9. Answer the question **PERFORM MAX ENERGY?** by pushing **YES** or **NO**. This allows the maximum energy and charge time test to be bypassed if desired.

10. If **YES** is pushed, enter the "+" limits in joules (not percent) for this test. Push **DOWN** or **UP**, followed by **ENTER**.

    Then enter the "-" limits in joules (not percent) for this test. Again push **DOWN** or **UP**, followed by **ENTER**.

11. Answer the question **PERFORM CARDIO?** Three cardioversion tests will be performed if **YES**.

12. Answer the question **RUN PERF WAVES** by pushing **YES** or **NO**.

13. Having completed the sequence programming, to store the custom sequence permanently in non-volatile memory, push **YES** when the display says **DONE, OK TO STORE?** (Pushing **NO** abandons the sequence.)

    The sequence can now be used.

14. Push **MENU/ESC** from the **CUSTOM AUTOSEQUENCES** menu to return to the main menu.

Viewing Autosequences

Any autosequence can be viewed to see its current contents.

To view an autosequence:

1. Push **VIEW** from the **CUSTOM AUTOSEQUENCES** menu.
2. Select the sequence desired.
3. Push **ADV** to step through everything programmed in a sequence—energy levels, limits, and options selected.

   Pushing **MENU/ESC** aborts the viewing and returns to the **CUSTOM AUTOSEQUENCES** menu.
4. Push **MENU/ESC** from the **CUSTOM AUTOSEQUENCES** menu to return to the main menu.

Table 1 • Factory-Initialized Autosequences

SEQUENCE # / NAME	1 LP4	2 LP5	3 LP6	4 LP6S	5 LP7	6 LP8
DEFIB TYPE	Physio-Control Lifepack 4	Physio-Control Lifepack 5	Physio-Control Lifepack 6	Physio-Control Lifepack 6S	Physio-Control Lifepack 7	Physio-Control Lifepack 8
ENERGY LEVEL TESTS 1	10	20	5	5	5	2
2	25	50	10	10	10	5
3	50	100	20	20	20	9
4	100	200	30	30	30	10
5	200	300	50	50	50	20
6	300	360	100	100	100	30
7	400		200	150	200	50
8	450		300	200	300	100
9			400	300	360	150
10				360		200
11						300
12						360
13						
14						
15						
16						
17						
18						
19						
20						
+ LIMIT (%)	10	10	10	10	10	10
- LIMIT (%)	10	10	10	10	10	10
V-FIB ON?	NO	NO	NO	NO	NO	NO
MAX ENERGY?	YES	YES	YES	YES	YES	YES
MAX + LIMIT	480	396	428	385	385	385
MAX - LIMIT	418	324	372	335	335	335
CARDIO?	YES	YES	YES	YES	YES	YES

Table 2 • Factory-Initialized Autosequences

SEQUENCE # NAME	7 M/D3	8 HP660	9 NK7K	10 HS2K	11 AOLOWN	12 M/D4
DEFIB TYPE	Quinton Instrument Quinscope M/D3	Hewlett Packard 78660A	Nihon Kohden 7000	Heartstart HS2000	Agilent LOWN	Quinton Instrument M/D4
1	5	5	3	200	5	1
2	10	10	5	200	10	8
3	20	20	10	360	20	40
4	35	40	20	200	30	80
5	50	60	30	200	40	160
6	75	100	50	360	50	240
7	100	150	70		100	320
8	150	200	100		150	
9	200	250	150		200	
10	300	300	200		300	
11	400	360	300		360	
12			360			
13						
14						
15						
16						
17						
18						
19						
20						
+ LIMIT (%)	10	10	10	10	15	20
- LIMIT (%)	10	10	10	10	15	20
V-FIB ON?	NO	NO	NO	YES	NO	NO
MAX ENERGY?	YES	YES	YES	NO	YES	YES
MAX LIMIT	440	400	396		414	384
[illegible]	360	330	324		306	256
[illegible]	YES	YES	YES	NO	YES	YES

Table 3 • Factory-Initialized Autosequences

SEQUENCE # NAME	13 M/D2	14 M/D2J	15 HP670	16 HP431	17 ZOLL	18 LP10
DEFIB TYPE	Data-scope M/D2	Data-scope M/D2J	Hewlett Packard HP75670A	Hewlett Packard HP43100	Zoll PD2000	Physio Control LP10
ENERGY LEVEL TESTS 1	8	5	5	2	2	5
2	20	10	10	3	3	10
3	30	20	20	5	5	20
4	40	40	30	7	7	50
5	50	75	50	10	10	100
6	100	100	70	20	20	200
7	200	200	100	30	30	300
8	300	300	150	50	50	360
9	400	400	200	70	100	
10		460	300	100	150	
11			360	150	200	
12				200	300	
13				300	360	
14				360		
15						
16						
17						
18						
19						
20						
+ LIMIT (%)	20	10	15	15	10	10
- LIMIT (%)	20	10	15	15	10	10
V-FIB ON?	NO	NO	NO	NO	NO	NO
MAX ENERGY?	YES	YES	YES	YES	YES	YES
MAX + LIMIT	480	506	414	414	396	396
MAX - LIMIT	320	404	306	306	324	324
CARDIO?	YES	YES	YES	YES	YES	YES

Table 4 • Custom Autosequences

SEQUENCE # / NAME						
DEFIB TYPE						
ENERGY LEVEL TESTS	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
+ LIMIT (%)						
- LIMIT (%)						
V-FIB ON?						
MAX ENERGY?						
MAX + LIMIT						
MAX - LIMIT						
CARDIO?						

Option 1:
ECG Waveforms

The ECG menu provides ECG waveform simulations in four submenu categories, each with up to eight selections.

The submenu categories and their waveforms are as follow:

NORM — Normal Sinus Rhythms	
30	BPM
60	BPM
80	BPM
120	BPM
160	BPM
200	BPM
240	BPM
300	BPM

SVARR — Supraventricular Arrhythmias	
AFIB1	Atrial fibrillation, coarse
AFIB2	Atrial fibrillation, fine
AFLUT	Atrial flutter
SINAR	Sinus arrhythmia
1AVB	1° A-V block
2AVBI	2° A-V block type I
2AVBII	2° A-V block type II
3AVB	3° A-V block

VENT1 — Ventricular Group 1	
PVC1	PVCs type 1
PVC2	PVCs type 2
MF	Multifocal PVCs
COUPL	Couplet of PVCs
BIGEM	Bigeminy
TRIGEM	Trigeminy
RUN5	Run of 5 PVCs
RUN11	Run of 11 PVCs

VENT2—Ventricular Group 2	
VENT	Ventricular rhythm 120
VT130	Ventricular tachycardia 130
VT180	Ventricular tachycardia 180
VT220	Ventricular tachycardia 220
VFIB1	Ventricular fibrillation, coarse
VFIB2	Ventricular fibrillation, fine
EMD	Electromotive disassociation
ASYS	Asystole

To start the waveform running:

1. Push **ECG** from the main menu.
2. Select the appropriate submenu—**NORM**, **SVARR**, **VENT1**, or **VENT2**.
3. Then select the desired waveform.

Option 1: EMT-D (Emergency Medical Technician-Defibrillator) Interactive Training

The Impulse 3000 has been programmed with several special ECG waveform sequences that include fibrillation and that interact with the incoming defibrillator pulse. These sequences can be used for training to see what the fibrillation waveforms and the results of defibrillation look like.

There are seven emergency sequences and one elective cardioversion sequence.

To enter the **EMT-D TRAINING MENU**:

1. Push **EMTD** from the main menu.
2. Then select a sequence—**EMRG1** through **EMRG7** or **CARDIO**.
3. Switch the range setting if prompted.
4. Push **START** to start the waveform.

Convention

At any time during an EMT-D sequence:

- Pushing **MENU/ESC** returns to the **EMT-D TRAINING MENU.**
- Pushing **START** starts the sequence running again from the beginning.

The Impulse 3000 has a feature designed to save wear and tear on defibrillators by providing that any EMT-D scenario can be defibrillated at one-tenth the required energy. To access this feature:

1. Press **MENU/ESC** until **UTIL** shows on the main menu.
2. Press **UTIL.**
3. Press **EMTD.**
4. Select either **NORM** or **÷10.**
5. Press **STORE** to save the data in memory.

A form that is designed to be a training record will be printed via the RS-232 port every time the instrument runs an EMT-D scenario. All waveform and defibrillator activity is recorded along with the elapsed time for each event. Spaces are included for filling in pertinent information and checking off evaluation items.

The Emergency Sequences

The following applies to all seven emergency sequences:

- The seven emergency sequences feature ventricular fibrillation either at the start or after running for a while.
- Whenever v-fib is active, it is displayed on the Impulse display and the defibrillator can be fired into the Impulse. The energy of the defibrillator pulse is measured and displayed "**E =.**"
- Some sequences require a certain energy of defibrillation or sequence of energies to convert to a normal ECG waveform. In this case, the pulse energy is allowed to be as much as 10 percent lower than that specified to allow for variation.

- Pushing **DEFIB** substitutes the internal test pulse for an actual pulse and assumes that the pulse is the correct energy for the current sequence. "**XXX.X J**" is displayed for the test pulse.

- If v-fib is not active, firing the defibrillator into the Impulse will have no effect. Once the ECG waveform enters asystole, no further action will change it (except restarting the sequence).

- When a defibrillator pulse or test pulse is fired into a v-fib waveform, the resultant waveform goes negative as far as it can, then recovers to a baseline in about three seconds. Then it will either convert to a normal heartbeat or re-enter v-fib.

- If converting to normal, the display will indicate "**converted**" and the ECG waveform will make 3 beats of a nodal rhythm at 30 BPM, 6 nodal beats at 60 BPM, and then will continue on with a normal sinus rhythm at 80 BPM. Otherwise, the display will show "**not converted**" and the ECG waveform will go back to v-fib.

Emergency 1 and 2

Emergency 1 sequence starts with an 80-BPM normal sinus rhythm for 10 beats, a PVC (R on T), 6 normal beats, another PVC (R on T) and then goes to a continuous v-fib.

Emergency 2 sequence starts with 10 normal beats, then has 25 beats of ventricular tachycardia, and then also goes to a continuous v-fib.

For both Emergency 1 and Emergency 2 sequences, firing the defibrillator at any energy level will convert to a normal ECG.

Emergency 3

Emergency 3 sequence starts with v-fib. If a 200-joule pulse is fired within 2 minutes of starting, the waveform converts to normal. Otherwise the ECG goes to asystole

Emergency 4

Emergency 4 is the same as Emergency 3 except two pulses at 200J are required within 2 minutes to convert to normal.

Emergency 5

Emergency 5 is the same as Emergency 3 and 4 except that two pulses at 200J followed by one pulse at 360J are required within 2 minutes to convert to normal.

Emergency 6

Emergency 6 is the same as Emergency 5 except that after converting to normal and beating normally for 3 minutes, the ECG shows 2 PVCs (R on T) and then re-enters v-fib. The same series of two pulses at 200J and one at 360J are required again within 2 minutes to convert to normal. Otherwise the ECG goes to asystole.

Emergency 7

Emergency 7 starts at ventricular tachycardia at 180 BPM for 1 minute then goes to v-fib. Any defibrillator pulse within 2 minutes will convert to normal. Otherwise the ECG goes to asystole.

The Cardioversion Sequence

To enter the Cardioversion sequence:

1. Push **CARDIO** to enter the Cardioversion sequence.

2. Push **START** to start the waveform which is a continuous atrial fibrillation (a-fib). The display says "**a-fib.**"

   The "patient" must be defibrillated synchronously to be successful.

3. Fire a real synchronized defibrillator into the load or push **SYNC** to use the test pulse.

   If the defibrillator pulse comes within 120 ms of the ECG R-wave, then the defibrillation is successful. The display reads "**sync OK**" then "**converted**" and the waveform is the same as in the emergency sequences for successful defibrillation.

   If the defib pulse is not synchronized within 120 ms or if the **LATE** button for a test pulse is pushed, the waveform will show the onset of v-fib. Then the "patient" is in an emergency condition. Now a 200J pulse is required to convert the waveform to normal.

Option 1:
Impulse 3000-to-medTester Interface

Important

Any medTester used for this procedure must be at version 3.16 or greater.

The Impulse 3000 (version 1.05 or greater) must have Option 1 installed.

To interface with a medTester when running a medTester defibrillator autosequence:

1. Connect an RS-232 interface cable (DNI part # 3010-0300) from the Impulse 3000 to COM 2 of the medTester.

2. Turn both units on.

3. For medTesters prior to version 5.00, you must set the defibrillator load to **IMPULSE**. For medTester version 5.00 or later, skip this step.

   From the medTester **DEFIB** menu:

   - Select **CASO**, **LOAD**, and then **IMPULSE**.

4. Start the medTester defibrillator autosequence. The medTester baud rate is automatically set to 2400.

   - Operate the autosequence until the medTester display indicates "**ready**" and the medTester is waiting to accept defib energy information.

5. From page 2 of the main menu of the Impulse 3000, select **MEDT**.

   The display will read "**w/ medTester: ready**".

   "**VFIB**" and "**TEST**" appear above the **F3** and **F4** function keys.

   At this point, there is an ECG waveform present at the ECG jacks of the Impulse 3000 (a mode similar to **CARDIOVERSION**).

The baud rate of the Impulse 3000 is automatically set to 2400 upon entering this mode.

6. Push **VFIB** to change the ECG waveform from normal to ventricular fibrillation.

7. Discharge the defibrillator into the Impulse 3000 when both the Impulse and the medTester displays indicate "**ready.**"

   The Impulse will then send data to the medTester containing the defibrillator energy and cardio delay time.

   If **VFIB** was selected, the delay time is meaningless and is sent as "**YYY.**" The Impulse 3000 display will show the delay time in milliseconds (**ms**) and the energy (**E=**) in joules (**J**).

   The Impulse 3000 display returns to "**w/ medTester ready**" and the ECG waveform resumes at the ECG jacks.

8. Pressing **MENU/ESC** to go back to page 2 of the main menu sets the baud rate back to its previous setting.

Chapter 4

Performance Test

The performance test checks that the instrument operates properly.

The performance test is usually performed upon the initial receipt of the instrument.

Test Procedure

1. Connect a voltage supply of +9V ±1V, to the Impulse 3000 power input.

   Either a battery or the battery eliminator can be used for most of these checks, but a supply that can be adjusted down to +6V must be used for the last check which tests the low-battery circuit.

2. Check that the instrument operates when power is applied both through the battery eliminator jack and through the battery terminals.

3. Power up the Impulse 3000.

4. First the software revision number is displayed followed by the main menu.

5. Check that the power supply current drain is 26 mA or less.

6. Push MENU/ESC, then UTIL, then VIEW.

7. Adjust the viewing angle through its limits 1 through 8 and check that the actual resulting display viewing angle changes and is suitable for proper reading of the display.

8. Test the nonvolatile storage of the EEPROM U2 by storing a different viewing angle than was originally stored.

9. Turn off the power and turn it back on.

10. Check that the new viewing angle is the same as what was stored.

11. Return to the first main menu.

12. Push **ENERGY**.

13. With the instrument in either the **HI** or **LO** ranges, push **TEST** when "**ready**" is displayed.

14. Check that the Impulse displays the energy of the test pulse. The **HI** range should read **100J ± 4.0J**, and the **LO** range should read **4J ± 0.4J**.

15. Push **CARDIO**.

16. Push **TEST** when "**ready**" is displayed.

17. Check that the Impulse displays a delay time of 20 ms.

18. Return to the main menu by pressing **MENU/ESC**.

19. Push **PERF**, then **MAN**, and then select the 2-Hz square wave.

20. Check that there is a 2-Hz square wave with a 1-volt amplitude at the **ECG 1V** jack.

21. Use a differential input oscilloscope with 0.5 mV/division vertical resolution to measure the low-level ECG from the top panel binding posts on the Impulse 3000.

22. Connect the positive oscilloscope test lead to the black left arm (**LA**) post, the negative oscilloscope test lead to the white right arm (**RA**) post, and the ground lead to the green right leg (**RL**) post.

23. The 2-Hz square wave amplitude should measure 1 mV ± 0.05 mV, and the frequency should be 2 Hz ± 0.02 Hz.

24. In the manual **ENERGY** mode, fire an actual defibrillator into the Impulse 3000 and check that the energy reading is correct.

25. In real time, check that the scope output works correctly. The attenuation factor for the real-time oscilloscope is 1000:1. For example, a 1-volt signal measured at this output is equivalent to 1000 volts applied to the Impulse 3000 electrode contact plates.

26. Do the above tests for both ranges with appropriate energy levels for each.

27. Connect an RS-232 receiving device such as a printer or terminal to the RS-232 jack on the right side panel through an interface cable.

28. Push **UTIL** from the second main menu, then push **RS-232**.

29. Adjust the Impulse's **BAUD** rate to match the receiver if necessary.

30. From the **RS-232 SERIAL PORT SETUP**, push **TEST** to output a test sentence to the port and verify that it is read by the receiver.

31. Reduce the supply voltage smoothly to +6.0V ±.05V.

32. Wait for 2 seconds.

33. Check that the Impulse displays "**LOW BATTERY.**"

34. Turn the power off.